Human Evolution

* Who are we?
* Where did we come from?
* What is the human genealogy?
* These are basic questions that we all ask
* Humans did not evolve **from** Apes
* You are **descended** from your mother and father
* You are **related** to your aunt and cousin

What is a Hominid?

* Modern humans & our direct and indirect ancestors after our lineage split from the chimpanzee
* Until recently, earliest hominids were dated between 3.5 and 2.4 mya & placed in the genus *Australopithecus*
* In last few years, time range of *Australopithecus* pushed back to 4.2 mya, distribution expanded to include regions outside E. and S. Africa
* New finds from 4.5-7 mya are thought to be hominids that predate Australopithecines, although their status is debated

Earliest fossil hominid sites are in Africa

* They now span the latest Miocene to the early Pleistocene from about 6-7 mya to about 1.6 mya
* The major groups of sites are:
  + Ethiopia = Middle Awash valley & Hadar (*Australopithecus afarensis*)
  + Kenya = Lake Turkana
  + Tanzania = Olduvai Gorge
  + South Africa = various sites in limestone caverns centered around Sterkfontein

Hope of Life

* A skull found in the African nation of Chad, in 2002 and named *Sahelanthropus tchadensis* but nicknamed Toumaï, which means "hope of life" in the local Goran language, has pushed back the origins of humans to nearly 7 million years ago
* Another discovery reported in 2006 provides strong evidence for an ancestor-descendant relationshipbetween two early hominid lines, one of which leads to our own human heritage

So where does this leave us, evolutionarily speaking?

* At a very exciting time as we seek to unravel the history of our species
* Our understanding of our genealogy is presently in flux, and each new fossil hominid find sheds more light on our ancestry
* Apparently human evolution is just like that of other groups
* We have followed an uncertain evolutionary path
* As new species evolved, they filled ecologic niches and either gave rise to descendants better adapted to the changing environment or became extinct
* Our own evolutionary history has many dead-end side branches

What Are Primates?

* Primates are difficult to characterize as an order
  + they lack the strong specializations found in most other mammalian orders
* We can, however, point to several trends in their evolution that help define primates and are related to their arboreal, or tree-dwelling, ancestry

Trends in Primates

* These include changes in the skeleton
  + and mode of locomotion
  + an increase in brain size
  + a shift toward smaller, fewer and less specialized teeth,
  + and the evolution of stereoscopic vision
  + and a grasping hand with opposable thumb
* Not all these trends took place in every primate group nor did they evolve at the same rate in each group

Why did bipedalism become the primary adaptation of hominids?

* Carrying behavior
* Reduction of overall heat stress - facilitates heat loss through convection by exposing body to air currents, only humans have sweat glands that produce moisture to cool body
* Most energy efficient way to travel long distances
* Allows for better vision in open environments & defensive action against predators by freeing hands to throw objects

Classification of primates

* The primate order is divided into two suborders:
* Prosimians, or lower primates
  + include the lemurs, lorises, tarsiers, and tree shrews,
* Anthropoids, or higher primates,
  + include monkeys, apes, and humans
* Order Primates:
  + Suborder Prosimii: (lower primates) Lemurs, lorises, tarsiers, tree shrews
  + Suborder Anthropoidea: (Higher primates) Monkeys, apes, humans
    - Superfamily Cercopithecoidea: Macaque, baboon, proboscis monkey (Old World monkeys)
    - Superfamily Ceboidea: Howler, spider, and squirrel monkeys (New World monkeys)
    - Superfamily Hominoidea: Apes, humans
      * Family Pongidae: Chimpanzees, orangutans, gorillas
      * Family Hylobatidae: Gibbons, siamangs
      * Family Hominidae: Humans

Prosimians

* Prosimians are generally small,
  + ranging from species the size of a mouse up to those as large as a house cat
* They are arboreal, have five digits
  + on each hand and foot with either claws or nails,
  + are typically omnivorous
* They have large, forwardly directed eyes
  + specialized for night vision, hence most are nocturnal
* Decline due to weather change
* As the continents moved northward during the Cenozoic
  + the climate changed from warm tropical to cooler mid-latitude conditions,
  + the prosimian population decreased in both abundance and diversity
  + By the Oligocene, hardly any prosimians were left in the northern continents as the once widespread Eocene populations migrated south to the warmer latitudes of Africa, Asia, and Southeast Asia
* Presently, prosimians are found only in the tropical regions of Asia, India, Africa, and Madagascar.
* As their name implies pro means "before," and simian means "ape”,
* prosimians are the oldest primate lineage, and their fossil record extends back to the Paleocene
* During the Eocene prosimians were abundant, diversified, and widespread in North America, Europe, and Asia

Anthropoids

* Anthropoids evolved from a prosimian lineage
  + sometime during the Late Eocene and by the Oligocene they were well established
* Anthropoids are divided into three superfamilies

Old World Monkey

* are characterized by close-set, downward-directed nostrils
  + like those of apes and humans
* grasping hands, and a nonprehensile tail
* They include
  + the macaque, baboon, and proboscis monkey
* Present-day Old World monkeys are distributed in the tropical regions of Africa and Asia are thought to have evolved from a primitive anthropoid ancestor, such as *Aegyptopithecus*, sometime during the Oligocene

New World Monkeys

* are found only in Central and South America
* They probably evolved from African monkeys that migrated across the widening Atlantic sometime during the Early Oligocene, and they have continued evolving in isolation to this present day
* No evidence exists of any prosimian or other primitive primates in Central or South America nor of any contact with Old World monkeys after the initial immigration from Africa
* New World monkeys are characterized
  + by a prehensile tail, flattish face
  + widely separated nostrils
  + include the howler, spider, and squirrel monkeys

Great Apes

* consist of three families:
  + the ***great apes***
    - family Pongidae
    - which includes chimpanzees, orangutans, and gorillas
  + the ***lesser apes***
    - family Hylobatidae
    - which are gibbons and siamangs;
  + and the ***hominids***
    - family Hominidae
    - which are humans and their extinct ancestors
* The hominoid lineage diverged from Old World monkeys
  + sometime before the Miocene, but exactly when is still being debated
  + It is generally accepted, however, that hominoids evolved in Africa,
  + probably from the ancestral group that included *Aegyptopithecus*
  + As the climate changed, the primate populations also changed
  + Prosimians and monkeys became rare, whereas hominoids diversified in the newly forming environments and became abundant
  + Ape populations became reproductively isolated from each other within the various forests, leading to adaptive radiation and increased diversity among the hominoids
  + During the Miocene, Africa collided with Eurasia, producing additional changes in the climate, provided opportunities for migration of animals between the two landmasses
  + Two apelike groups evolved during the Miocene ultimately gave rise to present-day hominoids
  + Although scientists still disagree on the early evolutionary relationships among the hominoids fossil evidence and molecular DNA similarities between modern hominoid families is providing a clearer picture of the evolutionary pathways and relationships among the hominoids

Early History of Anthropoids

* Much of our knowledge about the early evolutionary history of anthropoids
  + comes from fossils found in the Fayum district,
  + a small desert area southwest of Cairo, Egypt
* During the Late Eocene and Oligocene,
  + this region of Africa was a lush, tropical rain forest
  + supported a diverse and abundant fauna and flora
* Within this forest lived many different
  + arboreal anthropoids as well as various prosimians
* Several thousand fossil specimens have been recovered from rocks of this region
  + representing more than 20 species of primates
  + One of the earliest anthropoids, *Aegyptopithecus*,
    - a possible ancestor of the Old World monkeys
    - a small, fruit-eating, arboreal primate, about 5 kg
    - It had monkey characteristics and ape features
    - and is the closest link we currently have to Old World primates

The hominids (family Hominidae)

* The primate family that includes present-day humans and their extinct ancestors
* Have a fossil record extending back to almost 7 million years
* Several features distinguish them from other hominoids
* Hominids are bipedal;
  + that is, they have an upright posture,
  + which is indicated by several modifications in their skeleton
* Other features that distinguish hominids from other hominoids include
  + a reduced face
  + reduced canine teeth
  + omnivorous feeding
  + increased manual dexterity
  + use of sophisticated tools
* At present, no clear consensus exists on the evolutionary history of the hominid lineage
* This is partly because of the incomplete fossil record of hominids, as well as new discoveries, because some species are known only from partial specimens or fragments of bone
* Because of this, scientists even disagree on the total number of hominid species
* A complete discussion of all the proposed hominid species and the various competing schemes of hominid evolution is beyond the scope of this course
* However, we will discuss the generally accepted taxa and present some of the current theories of hominid evolution

Oldest known hominid

* Discovered in northern Chad's Djurab Desert in July, 2002
  + the nearly 7-million-year-old skull and dental remains of *Sahelanthropus tchadensis* “Toumai”
  + makes it the oldest known hominid yet unearthed and very close to the time when humans diverged from our closest-living relative, the chimpanzee
  + Currently, most paleoanthropologists accept that the human-chimpanzee stock separated from gorillas about 8 million years ago and humans separated from chimpanzees about 5 million years ago
  + Besides being the oldest hominid, *Sahelanthropus tchadensis* shows a mosaic of primitive and advanced features that has excited and puzzled paleoanthropologists
  + The small brain case and most of the teeth (except the canines) are chimplike
  + However, the nose, which is fairly flat, and the prominent brow ridges are features only seen, until now, in the human genus *Homo*
  + *Sahelanthropus tchadensis* may have been bipedal in its walking habits, but until bones from its legs and feet are found, that supposition remains conjecture
  + *Sahelanthropus* may represent a common ancestor of humans and chimpanzees; no consensus has been reached yet by the scientific community. The original placement of this species as a human ancestor but not a chimpanzee ancestor would complicate the picture of human phylogeny.
  + In particular, if Toumaï is a direct human ancestor, then its facial features bring into doubt the status of *Australopithecus* because its thickened brow ridges were reported to be similar to those of some later fossil hominids (notably *Homo erectus*), whereas this morphology differs from that observed in all australopithecines, most fossil hominids and extant humans
  + Another possibility is that Toumaï is related to both humans and chimpanzees, but is the ancestor of neither. The discoverers of *Orrorin tugenensis*, suggested that the features of *S. tchadensis* are consistent with a female proto-gorilla.
  + Even if this claim is upheld, then the find would lose none of its significance, for at present, few chimpanzee or gorilla ancestors have been found anywhere in Africa.
  + If *S. tchadensis* is an ancestral relative of the chimpanzees (or gorillas), then it represents the first known member of *their* lineage. Furthermore, *S. tchadensis* does indicate that the last common ancestor of humans and chimpanzees is unlikely to resemble chimpanzees very much, as had been previously supposed by some paleontologists
  + A further possibility, highlighted by research published in 2012, is that the human/chimpanzee split is earlier than previously thought, with a possible range of 7 to 13 million years ago (with the more recent end of this range being favored by most researchers), based on slower than previously thought changes between generations in human DNA.

Next oldest hominid

* The next oldest hominid is *Orrorin tugenensis*, whose fossils have been dated at 6 million years, in Kenya
  + consist of bits of jaw, isolated teeth, finger, arm, and partial upper leg bones
* At this time, debate continues as to exactly where *Orrorin tugenensis* fits in the hominid lineage
* If *Orrorin* proves to be a direct human ancestor, then australopithecines such as *Australopithecus afarensis* ("Lucy") may be considered a side branch of the hominid family tree
* *Orrorin* is both earlier, by almost 3 million years, and more similar to modern humans than is *A. afarensis*. The main similarity is that the Orrorin femur is morphologically closer to that of *H. sapiens* than is *Lucy's*; there is, however, some debate over this point

“Ardi”

* Sometime between 5.8 and 5.2 million years ago another hominid was present in eastern Africa
* *Ardipithecus ramidus kadabba* is older than its 4.4 million year old relative *Ardipithecus ramidus ramidus*
* *Ardipithecus ramidus kadabba* is very similar in most features to *Ardipithecus ramidus ramidus* but in certain features of its teeth is more apelike than its younger relative
* Although many paleoanthropologists think both *Orrorin tugenensis* and *Ardipithecus ramidus kadabba* were habitual bipedal walkers and thus on a direct evolutionary line to humans, others are not as impressed with the fossil evidence and are reserving judgment
* Until more fossil evidence is found and analyzed, any single scheme of hominid evolution presented here would be premature

Australopithecines

* Australopithecine is a collective term for all members of the genus *Australopithecus*
* Currently, five species are recognized:
  + *A. anamensis*
  + *A. afarensis*
  + *A. africanus*
  + *A. robustus*
  + *A. boisei*
  + Many paleontologists accept the evolutionary scheme in which *A. anamensis*, the oldest known australopithecine, is ancestral to *A. afarensis*, who in turn is ancestral to *A. africanus* and the genus *Homo*, as well as the side branch of australopithecines represented by *A. robustus* and *A. boisei*

*Australopithecus anamensis*

* The oldest known australopithecine is *Australopithecus anamensis*
  + discovered at Kanapoi, a site near Lake Turkana, Kenya,
* *A. anamensis,* a 4.2-million-year-old bipedal species
  + has many features in common with its younger relative, *A. afarensis*,
  + is more primitive in other characteristics, such as its teeth and skull
* *A. anamensis* is estimated to have been between 1.3 and 1.5 m tall and weighed between 33 and 50 kg
* A discovery in 2006 of fossils of *A. anamensis,* from the Middle Awash area in northeastern Ethiopia has shed new light on the transition between *Ardipithecus*  and *Australopithecus*.
* The discovery of *Ardipithecus* in the same region of Africa and same times as the earliest *Australopithecus* provides strong evidence that *Ardipithecus* evolved into *Australopithecus* and links these two genera in the evolutionary lineage leading to humans.

*Australopithecus afarensis*

* Preserved in volcanic ash at Laetoli, Tanzania
* Discovered in 1978 by Mary Leakey, these footprints proved hominids were bipedal walkers at least 3.5 million years ago
* The footprints of two adults and possibly those of a child are clearly visible in this photograph
* Most scientists think the footprints were made by *Australopithecus afarensis* whose fossils are found at Laetoli

*Australopithecus africanus*

* *A. afarensis* was succeeded by *Australopithecus africanus*, which lived 3.0–2.3 million years ago
* The differences between the two species are relatively minor
* They were both about the same size and weight, but *A. africanus* had a flatter face and somewhat larger brain
* *A. afarensis* had a brain size of 380–450 cubic centimeters (cc)
* larger than the 300–400 cc of a chimpanzee
* much smaller than that of present-day humans (1350 cc average)
* The skull of *A. afarensis* retained many apelike features
* massive brow ridges
* forward-jutting jaw, but its teeth were intermediate between those of apes and humans
* The heavily enameled molars
* probably an adaptation to chewing fruits, seeds, and roots
* It appears the limbs of *A. africanus* may not have been as well adapted for bipedalism as those of *A. afarensis*
* Both *A. afarensis* and *A. africanus* differ markedly from the so-called robust species
  + *A. boisei* (2.6–1.0 million years ago)
  + *A. robustus* (2.0–1.2 million years ago)
  + *A. boisei* was 1.2–1.4 m tall and weighed between 34 and 49 kg
  + It had a powerful upper body, a distinctive bony crest on the top of its skull, a flat face, and the largest molars of any hominids

*Australopithecus robustus*

* *A. robustus*, in contrast, was somewhat smaller (1.1–1.3 m tall) and lighter (32–40 kg)
* It had a flat face, and the crown of its skull had an elevated bony crest that provided additional area for the attachment of strong jaw muscles
* Its broad flat molars indicated *A. robustus* was a vegetarian
* Most scientists accept the idea that the robust australopithecines form a separate lineage from the other australopithecines that went extinct 1 million years ago

Why larger brains??

Larger brains have plausibly been connected with the evolution of a distinct human sexual psychology, favoring pair-bonding over promiscuity. Among both species of chimpanzees, females have exclusive charge of infants. Because of promiscuous sexual practices, paternity is generally not trackable. Australopithecines have similar brains and bodies and we have as yet no reason to think they didn't follow similar practices.

* A selection for larger brains -- for whatever reason -- would run up against the problem of a baby's larger head needing to pass through the bones surrounding the birth canal. The solution in place today is that human babies are born very prematurely compared to the offspring of our closest relatives. The still soft head of a new-born infant is deformed into a tube as it is squeezed through the birth canal.
* The price humans pay for this is a requirement of increased maternal care; for instance, for many months the baby is completely incapable of any form of locomotion, or even of clinging to the mother.
* Larger brains would have favored extending the period in which infants are primarily devoted to learning new skills. These factors are likely to have created a significant benefit for children who received care not only from their mothers but also from their fathers and possibly their grandmothers (in the latter case creating a selective pressure for menopause).
* In the case of fathers, natural selection would have favored males who were able to invest in their own rather than in others' offspring, thus creating selective pressures some way for males to track paternity.
* Pair-bonding is the likely solution -- one that necessitated novel psychological adaptations, possibly along with physiological ones such as continued sexual receptivity in females

The Human Lineage

*Homo habilis*

* The earliest member of our own genus *Homo* is *Homo habilis*,
  + lived 2.5-1.6 million years ago
* Its remains were first found at Olduvai Gorge, Tanzania,
  + but it is also known from Kenya, Ethiopia, and South Africa
* *H. habilis* evolved from the *A. afarensis* and *A. africanus* lineage and coexisted with *A. africanus* for about 200,000 years
* *H. habilis* had a larger brain (700 cc average) than its australopithecine ancestors, but smaller teeth
* It was about 1.2-1.3 m tall and only weighed 32-37 kg

*Homo erectus (“Tool Man”*

* In contrast to the australopithecines and *H. habilis*, which are unknown outside Africa, *Homo erectus* was a widely distributed species, having migrated from Africa during the Pleistocene
* Specimens have been found not only in Africa but also in Europe, India, China ("Peking Man"), and Indonesia ("Java Man")
* *H. erectus* evolved in Africa 1.8 million years ago and by 1 million years ago, moved into southeastern and eastern Asia, where it survived until about 100,000 years ago
* Although *H. erectus* developed regional variations in form, the species differed from modern humans in several ways
* Its brain size of 800-1300 cc, though much larger than that of *H. habilis*, was still less than the average for *Homo sapiens* (1350 cc)
* *H. erectus's* skull was thick-walled, its face was massive, it had prominent brow ridges, and its teeth were slightly larger than those of present-day humans
* *H. erectus* was comparable to size to modern humans, standing between 1.6 and 1.8 m tall and weighing between 53 and 63 kg
* The archaeological record indicates that *H. erectus* was a tool maker
* Furthermore, some sites show evidence that its members used fire and lived in caves, an advantage for those living in more northerly climates
* Our species, *H. sapiens* most certainly evolved from *H. erectus*

*Homo neanderthalensis*

* Perhaps the most famous of all fossil humans are the Neanderthals,
  + inhabited Europe and the Near East from about 200,000 to 30,000 years ago
* Some paleoanthropologists regard the Neanderthals
  + as a variety or subspecies of our own species (*Homo sapiens neanderthalensis*),
  + whereas others regard them as a separate species (*Homo neanderthalensis*)
* their name comes from the first specimens found in 1856 in the Neander Valley near Düsseldorf
* The most notable difference between Neanderthals and present-day humans is in the skull
  + Neanderthal skulls were long and low with heavy brow ridges, a projecting mouth, and a weak, receding chin
  + Their brain was slightly larger on average than our own, and somewhat differently shaped
* Archaeological evidence indicates Neanderthals lived in caves and participated in ritual burials such as occurred approximately 60,000 years ago at Shanidar Cave, Iraq
* The remains of Neanderthals are found chiefly in caves and hut-like rock shelters, which also contain a variety of specialized stone tools and weapons
* Archaeological evidence indicates that Neanderthals commonly took care of their injured and buried their dead, frequently with such grave items as tools, food, and perhaps even flowers
* The Neanderthal body was more massive and heavily muscled than oursrather short lower limbsmuch like those of other cold-adapted people of today
* Given the specimens from more than 100 sites, we now know Neanderthals were not much different from us, only more robust
* Europe's Neanderthals were the first humans to move into truly cold climates, enduring miserably long winters and short summers as they pushed north into tundra country

Cro-Magnons

* About 30,000 years ago,
  + humans closely resembling modern Europeans moved into the region inhabited by the Neanderthals and completely replaced them
* Cro-Magnons, the name given to the successors of the Neanderthals in France, lived from about 35,000 to 10,000 years ago; during this period the development of art and technology far exceeded anything the world had seen before
* Highly skilled nomadic hunters, Cro-Magnons followed the herds in their seasonal migrations
* They used a variety of specialized tools in their hunts, including perhaps the bow and arrow
* They sought refuge in caves and rock shelters and formed living groups of various sizes
* Cro-Magnons were also cave painters
* Using paints made from manganese and iron oxides, Cro-Magnon people painted hundreds of scenes on the ceilings and walls of caves in France and Spain, where many of them are still preserved today

Transition from *Homo erectus* to *Homo sapiens*

* Debate still surrounds the transition from *H. erectus* to our own species, *Homo sapiens*
  + Paleoanthropologists are split into two camps
* On the one side are those who support the replacement ("out of Africa") view
  + According to this camp, early modern humans evolved from a single woman in Africa, whose offspring then migrated from Africa, perhaps as recently as 100,000 years ago and populated Europe and Asia, driving the earlier hominid populations to extinction
* On the other side are those supporting the "multiregional" view
  + According to this hypothesis, early modern humans did not have an isolated origin in Africa, but rather established separate populations throughout Eurasia (H. erectus > H. neanderthalenis > H. sapiens
  + Occasional contact and interbreeding between these populations enabled our species to maintain its overall cohesiveness, while still preserving the regional differences in people we see today
* Beginning in the 1980's, Rebecca Cann, at the University of California, argued that the geographic region in which modern people have lived the longest should have the greatest amount of genetic diversity today.
* Through comparisons of mitochondrial DNA sequences from living people throughout the world, she concluded that Africa has the greatest genetic diversity and, therefore, must be the homeland of all modern humans.
* Assuming a specific, constant rate of mutation, she further concluded that the common ancestor of modern people was a woman living about 200,000 years ago in Africa.  This supposed predecessor was dubbed "mitochondrial Eve".
* More recent genetic research at the University of Chicago and Yale University lends support to the replacement model.  It has shown that variations in the DNA of the Y chromosome and chromosome 12 also have the greatest diversity among Africans today.
* Critics of the genetic argument for the replacement model also point out that the rate of mutation used for the "molecular clock" is not necessarily constant, which makes the 200,000 year date for "mitochondrial Eve" unreliable.
* The rate of inheritable mutations for a species or a population can vary due to a number of factors including generation time, the efficiency of DNA repair within cells, ambient temperature, and varying amounts of natural environmental mutagens.
* Further criticism of the genetic argument for the replacement model has come from geneticists at Oxford University.
* They found that the human beta-globin gene is widely distributed in Asia but not in Africa.  Since this gene is thought to have originated more than 200,000 years ago, it undercuts the claim that an African population of modern *Homo sapiens* replaced East Asian archaichumans less than 60,000 years ago.

The "multiregional" view

* Fossil evidence also is used to support the regional continuity model.  Its advocates claim that there has been a continuity of some anatomical traits from archaic humans to modern humans in Europe and Asia.  In other words, the Asian and European physical characteristics have antiquity in these regions going back over 100,000 years.  They point to the fact that many Europeans have relatively heavy brow ridges and a high angle of their noses reminiscent of Neanderthals. (Europeans have mixed with Neanderthals-most Europeans are between 2.6-3.2% Neanderthal)
* Similarly, it is claimed that some Chinese facial characteristics can be seen in an Asian archaic human fossil from Jinniushan dating to 200,000 years ago.  Like *Homo erectus*, East Asians today commonly have [shovel-shaped incisors](http://anthro.palomar.edu/homo2/glossary.htm#shovel-shaped_incisors) while Africans and Europeans rarely do.  This supports the contention of direct genetic links between Asian *Homo erectus* and modern Asians.

New Assimilation Model

* It is apparent that both the complete replacement and the regional continuity models have difficulty accounting for all of the fossil and genetic data.
* It takes a middle ground and incorporates both of the old models.
* It proposes that the first modern humans did evolve in Africa, but when they migrated into other regions they did not simply replace existing human populations.
* Rather, they interbred to a limited degree with late archaic humans resulting in hybrid populations.
* In Europe, for instance, the first modern humans appear in the archaeological record rather suddenly around 45-40,000 years ago.
* The abruptness of the appearance of these Cro-Magnon people could be explained by their migrating into the region from Africa via an eastern Mediterranean coastal route.
* They apparently shared Europe with Neandertals for another 12,000 years or more.  During this long time period, it is argued that interbreeding occurred and that the partially hybridized predominantly Cro-Magnon population ultimately became modern Europeans.
* In 2003, a discovery was made in a Romanian cave named Peştera cu Oase that supports this hypothesis.  It was a partial skeleton of a 15-16 year old male *Homo sapiens* who lived about 30,000 years ago or a bit earlier.  He had a mix of old and new anatomical features.
* The skull had characteristics of both modern and archaic humans.
* **A computer-based analysis of 10 different human DNA sequences indicates that there has been interbreeding between people living in Asia, Europe, and Africa for at least 600,000 years.**
* **This is consistent with the hypothesis that humans expanded again and again out of Africa and that these emigrants interbred with existing populations in Asia and Europe.**
* **It is also possible that migrations were not only in one direction--people could have migrated into Africa as well.  If interbreeding occurred, it may have been a rare event.  This is supported by the fact that most skeletons of Neandertals and Cro-Magnon people do not show hybrid characteristics.**

Denisovans

* Three years ago the genetic analysis of a little finger bone from Denisova cave in the Altai Mountains in northern Asia led to a complete genome sequence of a new line of the human family tree-the Denisovans.
* Since then, genetic evidence pointing to their hybridisation with modern human populations has been detected, but only in Indigenous populations in Australia, New Guinea and surrounding areas.
* In contrast, Denisovan DNA appears to be absent or at very low levels in current populations on mainland Asia, even though this is where the fossil was found.

*Homo sapiens* today

* With the appearance of Cro-Magnons, human evolution has become almost entirely cultural rather than biological. Humans have spread throughout the world by devising means to deal with a broad range of environmental conditions. Since the evolution of the Neanderthals about 200,000 years ago, humans have gone from a stone culture to a technology that has allowed us to visit other planets with space probes and land astronauts on the Moon.
* Are we still evolving?
  + Microevolution: change in gene frequency – YES
  + Macro evolution : formation of species – NO
* Are we genetically different from our *Homo sapiens* ancestors who lived 10-20,000 years ago?  The answer is almost certainly yes.  In fact, it is very likely that the rate of evolution for our species has continuously accelerated since the end of the last ice age, roughly 10,000 years ago.
* This is mostly due to the fact that our human population has explosively grown and moved into new kinds of environments, including cities, where we have been subject to new natural selection pressures.
* For instance, our larger and denser populations have made it far easier for contagious diseases, such as tuberculosis, small pox, the plague, and influenza to rapidly spread through communities and wreak havoc.  This has exerted strong selection for individuals who were fortunate to have immune systems that allowed them to survive.
* There also has been a marked change in diet for most people since the end of the last ice age.  It is now less varied and predominantly vegetarian around the globe with a heavy dependence on foods made from cereal grains.
* It is likely that the human species has been able to adapt to these and other new environmental pressures because it has acquired a steadily greater genetic diversity.  A larger population naturally has more mutations adding variation to its gene pool simply because there are more people.  This happens even if the mutation rate per person remains the same.  However, the mutation rate may have actually increased because we have been exposed to new kinds of man-made environmental pollution that can cause additional mutations.
* It is not clear what all of the consequences of the environmental and behavioral changes for humans have been.  However, it does appear that the average human body size has become somewhat shorter over the last 10,000 years, and we have acquired widespread immunity to the more severe effects of some diseases such as measles and influenza.

The Future

* It remains to be seen
  + how we will use this technology in the future
  + and whether we will continue as a species,
  + evolve into another species,
  + or become extinct as many groups have before us